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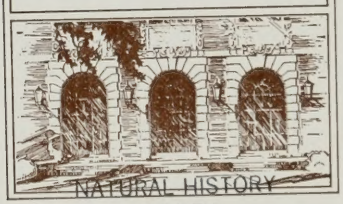

SURVEY

A BIBLIOGRAPHY OF THE

NORTHERN CORN ROOTWORM, *Diabrotica longicornis* (Say), and the WESTERN CORN ROOTWORM, *Diabrotica virgifera* LeConte (Coleoptera: Chrysomelidae)

W. H. Luckmann · H. C. Chiang · E. E. Ortman · Martha P. Nichols

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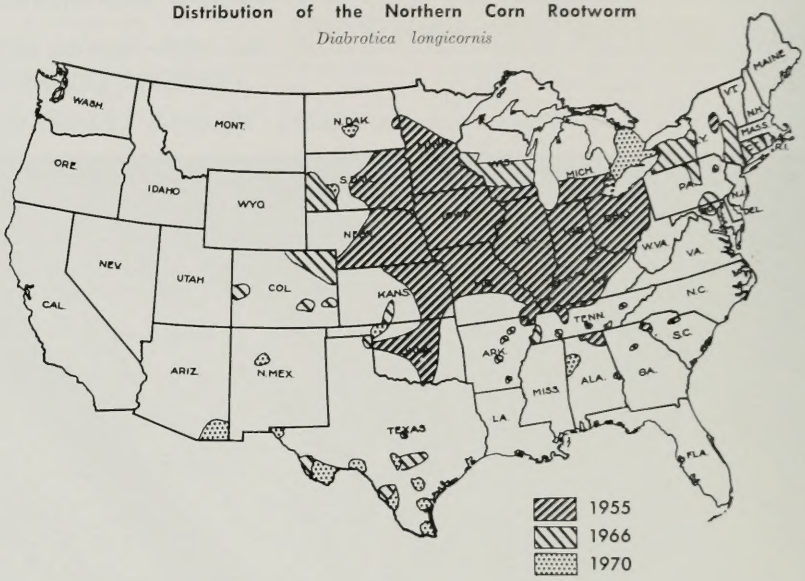
Department of Registration and Education
Natural History Survey Division

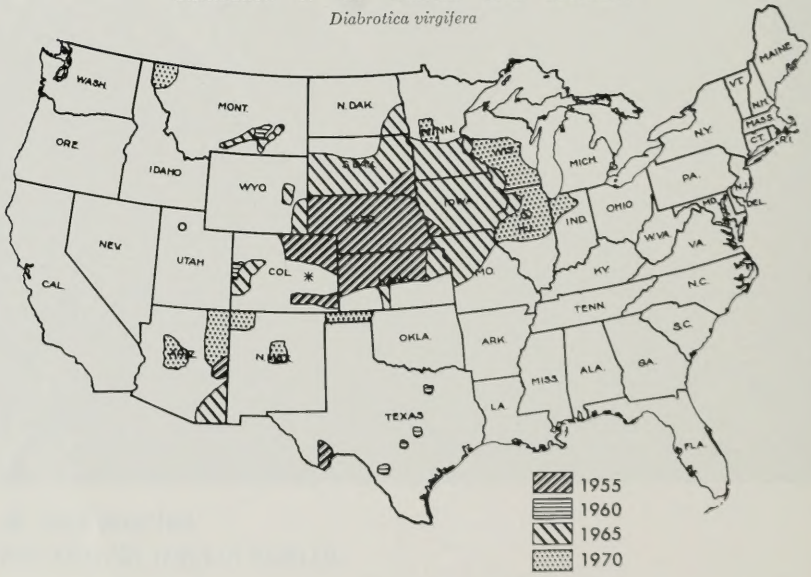
Distribution of the Northern Corn Rootworm

Diabrotica longicornis



Distribution of the Western Corn Rootworm

Diabrotica virgifera



COVER ILLUSTRATION — Northern corn rootworm adult (lower left) and western corn rootworm adult (upper right). Photo by Wilmer Zehr.

A BIBLIOGRAPHY OF THE NORTHERN CORN ROOTWORM AND THE WESTERN CORN ROOTWORM

W. H. Luckmann, H. C. Chiang, E. E. Ortman, and Martha P. Nichols

THIS BIBLIOGRAPHY is limited to papers dealing with the northern corn rootworm, *Diabrotica longicornis* (Say), and the western corn rootworm, *Diabrotica virgifera* LeConte. The 426 titles in the present list were obtained primarily from standard reference sources and the personal files of the authors.

The northern corn rootworm and the western corn rootworm are major pests of corn in the corn belt region of north-central USA. Distribution extends beyond this area, but damage by the larva is usually negligible south of latitude 30° N. The northern corn rootworm is most abundant in North America in an area roughly extending from latitude 37° to 45° N and longitude 80° to 100° W. The western corn rootworm is dispersing to the east and it is currently most abundant in an area roughly extending from latitude 40° to 45° N and longitude 85° to 105° W. Numerous isolated infestations of each species occur beyond these general boundaries south to the Mexican border and into Ontario, Canada, with new infestations reported each year. The two species are indigenous to North America.

The western corn rootworm is a product of modern agriculture. It intensified as a problem in irrigated corn in Nebraska about 30–40 years ago. Up to 1955, the western corn rootworm was found only in Nebraska and portions of Colorado, Kansas, South Dakota, and western Iowa. Since then it has moved eastward and northward into major corn-producing states. It developed resistance to the cyclodiene soil insecticides in the 1950's and the distribution of the resistant strain expanded northward and eastward.

The biology and behavior of the two species are very similar. In nature, corn is probably the only host, though it has been shown experimentally that the immatures of both species can develop to varying degrees on certain other species of grasses. Adults feed on the pollen, silks, and kernels of corn and on the fruiting structures of many other plants, including weeds.

The northern and the western corn rootworms have only one generation per year. Most eggs are laid in August in the soil in cornfields. The eggs are usually concentrated in the rows at the base of the corn plants in nonirrigated fields and between rows in fields with irrigation. Most eggs of the northern corn rootworm will be deposited in the upper few inches of soil. Ovipositional behavior of the western corn rootworm is slightly different, as females oviposit many of their eggs between the plant rows and eggs are often deposited at a greater depth in the soil. Following oviposition, eggs develop slightly and diapause through fall and winter. In the corn belt area of the USA the eggs begin to hatch in June and the first adults appear in July. Some eggs will not have hatched by the time the first adults appear. Thus, the egg stage lasts about 10 months, although, experimentally, a few eggs of the northern corn rootworm have been shown to go through two winters.

The larvae feed on corn roots and concentrate near the base of the plant. The larvae consume the roots, decreasing nutrition supplied to the ear, and in strong wind and rain storms plants with moderate to severe root damage may become lodged. The duration of the larval plus pupal stages is about 1 month. In laboratory cages, adult rootworm females will live about 2 months and oviposit for about 3 weeks, during which time they will deposit about 300–350 eggs. In the field, adult life probably does not exceed 5–6 weeks. There is a preoviposition period of 2–2½ weeks. Northern corn rootworms are very difficult to maintain in the laboratory, and culturing has not been very successful. The western corn rootworm can be cultured in the laboratory, but the egg diapause does not permit continuous mass rearing.

The adults may remain for a considerable time in the field where they emerge. Later they disperse, seeking pollen in late-maturing fields, alfalfa, and ornamental plants. Northern corn rootworm adults congregate on silks and in tips of ears of corn, whereas western corn rootworm adults have less tendency to congregate and they will be found on other parts of the plant as well as the ears. Thus counts made in ear tips will show a predominance of northern corn rootworm adults, whereas casual visual counts in the same field and at the same time show a predominance of western corn rootworm adults.

Northern corn rootworms and western corn rootworms live together and have similar habits, and there is some interaction between the two species. Several researchers have reported a displacement of the northern corn rootworm by the western corn rootworm. Interspecific matings have been observed in the fields, and F_1 progeny of crosses were produced in the laboratory. The F_1 adults have the phenotype of the western corn rootworm.

Larvae of northern corn rootworms and western corn rootworms are resistant to the cyclodiene insecticides over much of their range. Organophosphate and carbamate soil insecticides applied at planting time are used for control. Rotating corn with other crops is a positive means of control. Usually, only the larvae are damaging, but adults congregating and feeding on fresh silking ears

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can interfere with pollination, and in these instances insecticides are applied for adult control.

The brief introduction above, providing some general information about the western corn rootworm and the northern corn rootworm was written to assist the student and the researcher. All references in the bibliography were examined, except those preceded by the symbol #. A "Listing of References by Rootworm Species" has been included, following the numbered bibliography entries, so that users of the bibliography will be able to tell readily which of the numbered papers deal with which species of corn rootworms. A list of abbreviations used in the bibliography appears at the end of the paper.

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LISTING OF REFERENCES BY ROOTWORM SPECIES

I. Northern corn rootworm, *Diabrotica longicornis* (Say)

4, 14, 17, 19, 21, 25, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 46, 47, 58, 61, 62, 63, 64, 65, 66, 67, 68, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 88, 91, 93, 96, 98, 99, 100, 101, 102, 104, 107, 112, 114, 116, 117, 118, 119, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 135, 137, 138, 139, 141, 142, 143, 145, 147, 148, 154, 155, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 178, 179, 180, 189, 194, 195, 196, 197, 198, 199, 207, 208, 211, 212, 214, 215, 216, 217, 218, 219, 220, 222, 223, 224, 225, 229, 234, 235, 237, 238, 240, 241, 243, 249, 250, 251, 252, 254, 255, 256, 257, 258, 259, 264, 267, 268, 269, 270, 271, 272, 273, 278, 285, 286, 293, 295, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 318, 319, 320, 321, 323, 324, 325, 326, 327, 328, 329, 331, 333, 334, 336, 337, 338, 339, 340, 342, 343, 344, 346, 347, 348, 349, 352, 353, 354, 355, 357, 358, 359, 361, 363, 364, 369, 370, 371, 372, 374, 375, 376, 377, 378, 379, 380, 381, 382, 384, 385, 386, 387, 388, 389, 392, 393, 394, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 413, 416, 417, 418, 420, 422, 423, 424.

II. Western corn rootworm, *Diabrotica virgifera* LeConte

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III. *Diabrotica* spp.

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PERIODICAL ABBREVIATIONS

Agr. Chem. — Agricultural Chemicals.
Agr. Tec. Mex. — Agricultura Tecnica en Mexico.
Agrichem. Age — Agrichemical Age.
Agway Coop. — Agway Cooperator.
Amer. Entomol. — American Entomologist.
Ann. Entomol. Soc. Amer. — Annals of the Entomological Society of America.
Annu. Rev. Entomol. — Annual Review of Entomology.
Breeder's Gaz. — Breeder's Gazette.
Bull. Entomol. Soc. Amer. — Bulletin of the Entomological Society of America.
Bull. Ill. State Natur. Hist. Surv. — Bulletin of the Illinois State Natural History Survey.
Can. Entomol. — Canadian Entomologist.
Can. J. Genet. Cytol. — Canadian Journal of Genetics and Cytology.
Coleopt. Bull. — Coleopterists' Bulletin.
Colo. State Entomol. Circ. — Colorado State Entomologist Circular.
Commer. West — Commercial West.
Conn. Agr. Exp. Sta. Bull. — Connecticut Agricultural Experiment Station Bulletin.
Coop. Econ. Insect Rep. — Cooperative Economic Insect Report (USDA).
Co-op Grain Quart. — Co-op Grain Quarterly.
Country Gent. — Country Gentleman.
Crop Qual. Counc. Ext. Conf. Rep. — (Exact source unknown).
Crop Sci. — Crop Science.
Crops & Soils Mag. — Crops and Soils Magazine.
Doane's Agr. Rep. — Doane's Agricultural Report.
Entomol. Soc. Ont. Annu. Rep. — Entomological Society of Ontario Annual Report.
Ext. Serv. Rev. — Extension Service Review.
FAO Plant Prot. Bull. — FAO (Food and Agriculture Organization of the United Nations) Plant Protection Bulletin.
Farm Chem. — Farm Chemicals.
Farm J. — Farm Journal.
Farm Quart. — Farm Quarterly.
Folia Entomol. Mex. — Folia Entomologica Mexicana.
Geigy Agr. Chem. — Geigy Agricultural Chemicals.
Ill. Agr. Exp. Sta. Annu. Rep. — Illinois Agricultural Experiment Station Annual Report.
Ill. Agr. Exp. Sta. Bull. — Illinois Agricultural Experiment Station Bulletin.
Ill. Dep. Agr. Circ. — Illinois Department of Agriculture Circular
Ill. State Entomol. Annu. Rep. — Illinois State Entomologist Annual Report.
Iowa Agr. Exp. Sta. Circ. — Iowa Agricultural Experiment Station Circular.
Iowa Farm Sci. — Iowa Farm Science.
Iowa State Coll. Agr. Ext. Serv. Pamph. — Iowa State College Agricultural Extension Service Pamphlet.
Iowa State Coll. J. Sci. — Iowa State College Journal of Science.
Iowa State Univ. Coop. Ext. Serv. Pamph. — Iowa State University Cooperative Extension Service Pamphlet.
Irrig. Farmer — (Exact source unknown).
J. Acad. Natur. Sci. Philadelphia — Journal of the Academy of Natural Sciences of Philadelphia.
J. Agr. Food Chem. — Journal of Agricultural and Food Chemistry.
J. Agr. Res. — Journal of Agricultural Research.
J. Amer. Soc. Agron. — Journal of the American Society of Agronomy.
J. Econ. Entomol. — Journal of Economic Entomology.

J. Insect Physiol. — Journal of Insect Physiology.
J. Invertebr. Pathol. — Journal of Invertebrate Pathology.
J. Kans. Entomol. Soc. — Journal of the Kansas Entomological Society.
J. Minn. Acad. Sci. — Journal of the Minnesota Academy of Science.
Kans. Agr. Exp. Sta. Dir. Rep. — Kansas Agricultural Experiment Station Director's Report.
Kans. Farmer — Kansas Farmer.
Ky. Agr. Exp. Sta. Bull. — Kentucky Agricultural Experiment Station Bulletin.
Mem. Entomol. Soc. Can. — Memoirs of the Entomological Society of Canada
Mich. Agr. Exp. Sta. Quart. Bull. — Michigan Agricultural Experiment Station Quarterly Bulletin.
Mich. State Bd. Agr. Annu. Rep. — Michigan State Board of Agriculture Annual Report.
Mich. State Univ. Coop. Ext. Serv. Ext. Bull. — Michigan State University Cooperative Extension Service Extension Bulletin.
Minn. Agr. Ext. Fact Sheet Entomol. — (Exact source unknown).
Minn. Farm Home Sci. — Minnesota Farm and Home Science.
Minn. Sci. — Minnesota Science.
Miss. Ext. Serv. Circ. — Mississippi Extension Service Circular.
Mo. Agr. Exp. Sta. Bull. — Missouri Agricultural Experiment Station Bulletin
N. C. Dep. Agr. Bull. — North Carolina Department of Agriculture Bulletin
N. Dak. Farm Res. — North Dakota Farm Research.
Nebr. Agr. Exp. Sta. Annu. Rep. — Nebraska Agricultural Experiment Station Annual Report.
Nebr. Agr. Exp. Sta. Bull. — Nebraska Agricultural Experiment Station Bulletin.
Nebr. Agr. Exp. Sta. Ext. Circ. — Nebraska Agricultural Experiment Station Extension Circular.
Nebr. Agr. Exp. Sta. Quart. — Nebraska Agricultural Experiment Station Quarterly.
Nebr. Exp. Sta. Quart. — Nebraska Experiment Station Quarterly
Nebr. Farmer — Nebraska Farmer.
Nebr. State Bd. Agr. Annu. Rep. — Nebraska State Board of Agriculture Annual Report.
Nebr. State Entomol. Bull. — Nebraska State Entomologist Bulletin.
Ohio Agr. Exp. Sta. Bull. — Ohio Agricultural Experiment Station Bulletin.
Ohio Agr. Res. Develop. Center Res. Circ. — Ohio Agricultural Research and Development Center Research Circular.
Ohio Rep. Res. Develop. — Ohio Report on Research and Development.
Ohio State Univ. Agr. Ext. — Ohio State University Agricultural Extension.
Ont. Dep. Agr. Food Fact Sheet AGDEX — Ontario Department of Agriculture and Food, Fact Sheet AGDEX.
Pestic. Inst. News — The Pesticide Institute News.
Plant Dis. Rep. — Plant Disease Reporter.
Pract. Entomol. — Practical Entomologist.
Proc. Acad. Natur. Sci. Philadelphia — Proceedings of the Academy of Natural Sciences of Philadelphia.
Proc. Annu. Hybrid Corn Ind.-Res. Conf. — Proceedings of the Annual Hybrid Corn Industry-Research Conference (American Seed Trade Association).
Proc. Entomol. Soc. Wash. — Proceedings of the Entomological Society of Washington.
Proc. Indiana Acad. Sci. — Proceedings of the Indiana Academy of Science.
Proc. N. Cent. Br. Amer. Assoc. Econ. Entomol. — Proceedings of the North Central Branch of the American Association of Economic Entomologists.
Proc. N. Cent. Br. Entomol. Soc. Amer. — Proceedings of the North Central Branch of the Entomological Society of America.
Proc. Symp. Physiol. Ecol. Plants Anim. Extreme Environ. — Proceedings of the Symposium on Physiological Ecology of Plants and Animals in Extreme Environments, Dubrovnik, Yugoslavia.
S. Corn Impr. Conf. Rep. — Report of the Southern Corn Improvement Conference.
S. Dak. Farm Home Res. — South Dakota Farm and Home Research.
S. Dak. State Coll. Agr. Ext. — South Dakota State College of Agriculture Extension.
Trans. Amer. Entomol. Soc. — Transactions of the American Entomological Society.
Trans. Amer. Soc. Agr. Eng. — Transactions of the American Society of Agricultural Engineers.
25th Corn Sorghum Res. Conf. — 25th Corn and Sorghum Research Conference.
U.S. Commr. Agr. Annu. Rep. — United State Commissioner of Agriculture Annual Report.
U.S. Dep. Agr. Agr. Handb. — United States Department of Agriculture, Agriculture Handbook.
U.S. Dep. Agr. Bull. — United States Department of Agriculture Bulletin.
U.S. Dep. Agr. Div. Entomol. Bull. — United States Department of Agriculture, Bureau of Entomology, Bulletin.
U.S. Dep. Agr. Bur. Entomol. Circ. — United States Department of Agriculture, Bureau of Entomology, Circular.
U.S. Dep. Agr. Div. Entomol. Bull. — United States Department of Agriculture, Division of Entomology, Bulletin.
Univ. Calif. Publ. Entomol. — University of California Publications in Entomology.
Univ. Ill. Coop. Ext. Serv. Circ. — University of Illinois Cooperative Extension Service Circular.
Univ. Nebr. Agr. Ext. Serv. — University of Nebraska Agricultural Extension Service.
Va. J. Sci. — Virginia Journal of Science.
Va. Polytech. Inst. Ext. Leafl. — Virginia Polytechnic Institute Extension Leaflet.
Wis. Agr. Exp. Sta. Bull. — Wisconsin Agricutural Experiment Station Bulletin.

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